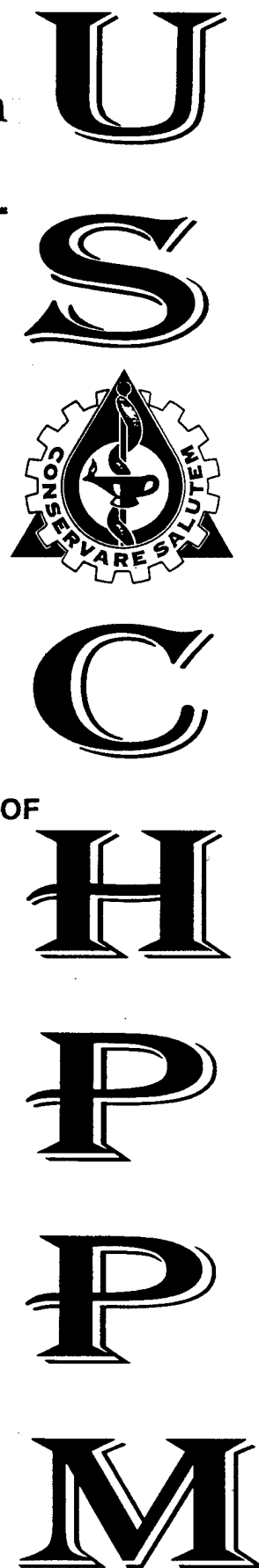


**U.S. Army Center for Health Promotion
and Preventive Medicine**

19990122 093

**EPIDEMIOLOGICAL CONSULTATION NO. 29-HE-7513-98
INJURY INCIDENCE, INJURY RISK FACTORS, AND PHYSICAL FITNESS OF
U.S. ARMY BASIC TRAINEES AT
FT JACKSON, SOUTH CAROLINA
1997**

Approved for public release; distribution unlimited.



Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

★ *Integrity is the foundation*

★ *Excellence is the standard*

★ *Customer satisfaction is the focus*

★ *Its people are the most valued resource*

★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE June, 1998		3. REPORT TYPE AND DATES COVERED Final
4. TITLE AND SUBTITLE Injury Incidence, Injury Risk Factors, and Physical DFitness of Army Basic Trainees, Ft Jackson, SC 1997			5. FUNDING NUMBERS	
6. AUTHOR(S) Dr Joseph Knapik (MAJ(R)), Ms Judith Cuthie, Ms Michelle Canham, MAJ William Hewitson, MAJ Mary Jo Laurin, Ms Mary Anne Nee, LTC Edward Hoedebecke, LTC Keith Hauret, COL Dale Carroll, COL Bruce Jones				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army Center for Health Promotion and Preventive Medicine Directorate of Epidemiology and Disease Surveillance Aberdeen Proving Ground, MD 21010 and Moncrief Army Community Hospital, Ft Jackson SC			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Center for Health Promotion and Preventive Medicine Directorate of Epidemiology and Disease Surveillance Aberdeen Proving Ground, MD 21010 and Moncrief Army Community Hospital, Ft Jackson SC			10. SPONSORING / MONITORING AGENCY REPORT NUMBER 29-HE-7513-98	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release, Distribution is Unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) An epidemiological consultation was requested by the Commander, U.S. Army Training Center, Ft. Jackson SC, to assist in the establishment of an Army Center of Excellence for the Study of Training-Related Injuries. A preliminary investigation of basic trainees was conducted to determine injury incidence, risk factors for injuries, physical fitness, and directions for a more comprehensive investigation. Data obtained on a battalion of basic trainees (n=799) included information from medical records, platoon manning rosters, Army Physical Fitness Test (APFT) scores, discharge packets, and newstart rosters. Cumulative injury incidence (one or more visits to a health care provider for overuse or traumatic events) was 15.4% for men and 38.0% for women. Univariate analysis indicated that injury risk factors among the men included a low number of push-ups or sit-ups on the first diagnostic APFT, high body mass index (body mass/ stature ²), lower rank, marital status (married), and lower educational level. Among the women, risk factors included older age, lower body mass, lower body mass index, slower first diagnostic two-mile run time, training company, and marital status (married). When marital status was stratified by age, injury incidence was similar in all age groups. APFT failures were associated with 79% of newstarts (i.e., recycles) into the battalion, 64% of newstarts leaving the battalion, and 47% of discharges. Comparisons with previous epidemiologic surveys of basic training show that: 1) the cumulative injury incidence was lower than seen in previous surveys (about 26% for men and 54% for women), possibly due to changes in BCT procedures (e.g., miles run in PT, more gradual introduction of physical training, etc.); 2) risk factors differed for men and women, but these risk factors were similar to those seen in past surveys; and 3) entry level fitness of men and women has declined over a 9 to 19 year period. More comprehensive studies are needed to 1) confirm the lower injury incidence and look for explanations, 2) obtain more complete injury data on discharges and newstarts, and 3) examine more physiologically accurate measures of fitness (e.g., VO2max, one repetition maximum strength, body composition by dual-X-ray absorptiometry, etc.).				
14. SUBJECT TERMS			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	

CONTENTS

	Page
Executive Summary	
1. Introduction	
2. Historical Background	
3. Purposes/Objectives	
4. Methods	
a. Data Sources	
(1) Platoon Manning Rosters (Demographics)	
(2) Medical Records (Injury Data)	
(3) Alpha Rosters, Newstarts, and Discharges	
(4) Army Physical Fitness Test (APFT) Data	
b. Injury Definitions	
c. Trainee Medical Care	
d. Data Analysis	
5. Results	
a. Data Collection and Limitations	
b. Physical and Demographic Characteristics	
c. Army Physical Fitness Test Data	
d. Injuries	
e. Risk Factors for Injuries	
f. Other Adverse Training Outcomes	
(1) Newstarts	
(2) Discharges	
(3) Injuries in Newstarts and Discharges	
g. Injuries in Trainees Coming from Fitness Training Unit (FTU)	
h. Company Personnel Status	
6. Discussion	
a. Injuries	
b. Injury Risk Factors	
c. Other Adverse Training Outcomes	
(1) Newstarts and Discharges	
(2) Injuries in Newstarts and Discharges	
d. Historical Trends in Physical Fitness	
7. Conclusions and Recommendations	
APPENDIX A -REFERENCES	
APPENDIX B - ACKNOWLEDGEMENTS	
APPDENIX C - DISTRIBUTION LIST	

EPIDEMIOLOGICAL CONSULTATION NO. 29-HE-7513-98
INJURY INCIDENCE, INJURY RISK FACTORS, AND PHYSICAL FITNESS OF
U.S. ARMY BASIC TRAINEES AT
FT JACKSON, SOUTH CAROLINA
1997

EXECUTIVE SUMMARY

1. INTRODUCTION. At the request of the Commander, U.S. Army Training Center, Ft Jackson South Carolina, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) conducted an epidemiological consultation to assist in establishing a U.S. Army Center for the Study of Training-Related Injuries at Ft Jackson. This report details the results of a preliminary investigation designed to determine current injury incidence, risk factors for injuries, physical fitness of trainees, and develop directions for a more comprehensive investigation.

2. DISCUSSION.

a. A retrospective cohort design was used for this preliminary survey. The cohort included all trainees in a single basic training battalion (2d Battalion, 60th Infantry Regiment) who had a medical record (n=799). Cases were trainees who had an injury recorded in his or her medical record. Data extracted from the trainees' medical records included the date of the visit, duration of symptoms, diagnosis, body part, side of body, disposition, and any days of limited duty. Information was also obtained from Platoon Manning Rosters, Army Physical Fitness Test (APFT) cards, alpha rosters, discharge packets, discharge summaries, and newstart rosters.

b. The cumulative incidence of injuries (trainees with one or more injuries) was 15.4% for men and 38.0% for women (risk ratio=2.5, $p<0.001$). For lower extremity overuse injuries, the cumulative incidence was 8.0% for men and 31.0% for women (risk ratio=3.9, $p<0.001$). The most common injury diagnosis was pain (not otherwise specified), accounting for 38% of all male injuries and 50% of all female injuries. Lower body injuries accounted for 72% of the male injuries and 83% of the female injuries. Injuries to the knee and below (shin, ankle, and foot) accounted for 62% of male injuries and 71% of female injuries. Cumulative incidence of stress fractures and stress reactions was 0.8% in men and 5.0% in women. The distribution of new injuries by the week of training was similar for both men and women with the highest number of cases in weeks 3 and 7. However, when the onset of symptoms was examined, it was found that both male and female trainees were more likely to have experienced symptoms early in training, especially in weeks 2 and 3.

c. Injury risk factors among women included older age, less body mass, lower body mass index ($BMI = \text{body mass}/\text{stature}^2$), slower first diagnostic run times, training company, and marital status (married). For the men, risk factors included a low number of first diagnostic push-ups or sit-ups, lower rank, marital status (married), and lower educational level. Marital status was related to age: older individuals more likely to be married. When marital status was stratified by age, injury incidence was similar in all age groups. Newstarts coming into the battalion from other battalions had elevated injury risk relative to those who were not newstarts ($RR=1.9$, $p<0.01$). Injuries were involved in 21% of newstarts (both coming into and leaving the battalion) and 23% of discharges.

d. On the APFT events, there were large improvements from the first diagnostic test (week 1 of training) to the final test (week 6 or 7 of training). For men, relative improvements on push-ups, sit-ups, and the 2-mile run were 55%, 48%, and 14%, respectively; for women these improvements were 150%, 67%, and 16%, respectively. On the first diagnostic test, APFT failure incidence (any single event below the 50-point value) was 67.6% of the men and 87.6% of the women. On the final test, APFT failure incidence was 2.5% of the men and 2.7% of the women. APFT failures accounted for 79% of the newstarts coming into the battalion and 64% of newstarts leaving the battalion. APFT failures were also associated with 47% of the Chapter 11 discharges (i.e., discharges for failure to meet entry level criteria in basic training).

4. FINDINGS AND CONCLUSIONS. In relation to past investigations of injuries in basic training there were three major findings.

a. First, injury incidence was lower than that seen in any other basic training study to date. In five past surveys, injury incidence has ranged from 23% to 28% for men, and 42% to 67% for women. The reasons for the lower incidence are not clear but may be related to changes in training. It is possible that running or marching mileage has been reduced to a level that has decreased injuries but retained favorable changes in fitness. We were told of other training practices such as the gradual introduction of physical training, ability group runs, and minimal fitness requirements for entry to regular basic training that may have favorably influenced injury incidence. Alternately, additional training requirements instituted since October 1997 may have caused trainees to delay seeking medical care for some injuries (presumably minor) in order to complete training requirements. The delay may have allowed these injuries to heal before medical care was obtained. The reason for the low injury incidence found in this study will require additional confirmation and a closer examination of day-to-day training.

b. A second major finding was that risk factors for injury differed for men and women, but there were similarities to risk factors found in other basic training studies.

Older age, body mass index, and lower levels of physical fitness have been demonstrated to increase injury risk in past surveys. Newstarts coming into the battalion have not been examined before and were found to have increased injury risk.

c. A third major finding was that entry level the physical fitness of new trainees appears to be lower than the physical fitness of trainees in previous years. Comparisons with past studies show that between 1978 and 1997, BMI (body mass index) has increased 7% and 4% in men and women, respectively. Between 1984 and 1997, push-ups have increased 3 repetitions among men but declined 2 repetitions among females; sit-ups have declined 15 repetitions for men and 13 repetitions for women. Between 1988 and 1997, 2-mile run times were 0.8 minutes slower for men and 1.2 minutes slower for women. The decline in fitness may be partly attributed to declines in physical activity prior to entry into the service; this is supported by data from the Centers for Disease Control and Prevention's Youth Risk Behavior Surveys.

5. RECOMMENDATIONS. The following suggestions are made for a follow-up investigation.

a. Observe basic training activities to see if particular training activities can be related to injury incidence. Keep a log of the actual number of daily miles that each company traverses including miles in running, marching to and from training, and road marching. Instrument a small number of trainees in each company with devices (e.g., accelerometers, foot strike monitors, etc.) that measure and record the total number of footsteps taken during the course of a day.

b. Obtain complete medical records on discharges and newstarts. Further, explore why newstarts coming in are at higher injury risk using simple questionnaire techniques.

c. Obtain more definitive measures of physical fitness and relate these to injury incidence. Measures obtained here and in the past have only been field measures and are not as accurate as such measures as VO_2 max (to measure cardiorespiratory endurance), one repetition maximums (to measure muscular strength), and dual energy X-ray absorptiometry (to measure body composition).

d. Examine physical activity levels of trainees prior to entry using questionnaire techniques. The lower levels of physical fitness may be due to lack of physical activity prior to service.

EPIDEMIOLOGICAL CONSULTATION REPORT NO. 29-HE-7513-98
INJURY INCIDENCE, RISK FACTORS, AND PHYSICAL FITNESS OF
U.S. ARMY BASIC TRAINEES AT
FT JACKSON, SOUTH CAROLINA
1997

1. INTRODUCTION. This epidemiological consultation was initiated in response to a letter from MG VanAlstyne (Commander, U.S. Army Training Center and Ft Jackson, South Carolina) to BG Patrick Sculley [Commander, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)] requesting assistance in establishing an Army Center for the Study of Training-Related Injuries. COL Bruce Jones (Director, Epidemiology and Disease Surveillance, USACHPPM) and COL Dale Carroll [Commander, Moncrief Army Community Hospital (MACH), Ft Jackson] outlined short- and long-term goals to get the project started. In October and November, 1997 meetings between members of the USACHPPM and MACH finalized plans for an initial survey of basic combat training (BCT) injuries at Ft Jackson. This report outlines the results of this preliminary survey and provides suggestions for a more comprehensive investigation.

2. HISTORICAL BACKGROUND.

a. Basic training injuries are of concern not only because of their frequency but also because they result in significant loss of manpower and can compromise training activities. Previous surveys of basic training outpatient medical records ("sick call" visits) have documented that the cumulative incidence of male trainees seeking medical care for one or more injuries during the 8 weeks of basic training has varied between 23 and 28%; cumulative incidence for women has ranged from 42 to 67% (5, 21, 32, 49). Injury rates per 100 person-months can be extrapolated from these data. For male trainees, the estimated rates lie between 12 and 14 injuries per 100 person-months; for female trainees the range is from 21 to 29 injuries per 100 person-months. Male U.S. Army Infantry trainees undergoing a 12-week period of basic training experience a cumulative incidence of injury of 46% (24), about 15 injuries per 100 person-months. Rates of this magnitude have also been observed for U.S. Marine Corps recruits (4).

b. Comparison of the limited duty days resulting from injuries versus illnesses provides perspective on the importance of injuries to overall U.S. military physical readiness. Table 1 displays the relative morbidity from injury versus illness and the rates of limited duty days. For male and female Army trainees, the relative rates of injury and illness (trainees with one or more) are about 1 to 1; however, for injuries, the rates of limited duty days are much higher than for illnesses. Injuries requiring outpatient care clearly cause significantly more temporary disability than illnesses.

Table 1. Relative Rates of Injury and Illness Among Army Trainees*

Category	Sample	Injury Rate (cases/100 trainee- mos)	Illness Rate (cases/100 trainee- mos)	Rate Ratio (injury rate/ Illness rate)
Trainees with One or More Visits	Male Trainees Female Trainees	13.7 visits 25.2 visits	17.7 visits 24.2 visits	0.8 1.0
Total "Sick Call" Visits	Male Trainees Female Trainees	22.1 visits 39.6 visits	26.4 visits 37.2 visits	0.8 1.0
Days of Limited Duty	Male Trainees Female Trainees	40 days 129 days	8 days 6 days	5.0 21.5

From Jones et al. (25)

c. Previous investigations have identified a number of factors that put basic trainees at higher injury risk. These risk factors may be categorized as either intrinsic or extrinsic in nature. Intrinsic factors are inherent characteristics of individuals, such as age, race, gender, anatomic characteristics, physical fitness, and so forth. Extrinsic factors are variables outside the individual, such as physical training programs, equipment, terrain, and weather conditions, which influence the risk of injury. Previously identified intrinsic risk factors include female gender (5, 21, 22, 24, 32), older age (6, 15, 24), white ethnicity (6, 15, 24, 29), high foot arches (12, 16), excessive (>15°) knee Q-angle (11), genu valgus (11), past ankle sprains (24), lower levels of aerobic fitness (21, 22, 49), high and low extremes of back and hamstring flexibility (24), lower levels of physical activity prior to entry into service (15, 21, 22, 24), and tobacco use (24, 29). Less consistently demonstrated intrinsic risk factors (i.e., not demonstrated in all studies) include lower levels of muscular strength/muscular endurance and higher body fat (2, 21, 22, 24, 49). Extrinsic risk factors that have been identified include greater running mileage during BCT (23, 24), and the use of older running shoes during training (15).

d. The factors determining risk of injury are clearly multifactorial and complex. For this reason, multivariate analytic techniques have been used to determine which constellations of intrinsic and extrinsic risk factors are most associated with risk of injury and to control interrelationships. Table 2 shows a multivariate analysis on male infantry basic trainees that examined risk factors for overuse injuries of the lower extremities (i.e., stress fractures, Achilles tendinitis, plantar fasciitis, and overuse knee syndromes) occurring during 12 weeks of infantry basic training (24). Table 2 indicates that independent risk factors for injuries in infantry basic trainees include older age, ethnicity other than Black, past ankle injuries, less physical activity during work or leisure time, and greater running mileage in BCT.

Table 2. Risk Factors for Lower Extremity Overuse Injuries Among Infantry Trainees with Adjusted Odds Ratios (OR) from Logistic Regression and 95% Confidence Interval (CI)

Risk Factor	Level of Factor	Injury OR	95% CI for OR
Age (years)	< 24	1.0	
	≥ 24	2.5	(1.2 - 5.2)†
Ethnicity	Black	1.0	
	Other	2.3	(0.5 - 9.4)
	White	3.7	(1.2 - 11.7)†
Past Ankle Injury	None	1.0	
	Sprain	2.0	(1.1 - 3.8)†
Past Job Activity	Moderate-Heavy	1.0	
	Light	2.0	(1.1 - 3.7)†
Past Physical Activity	Above Average	1.0	
	Average or Less	2.0	(1.1 - 3.5)†
Running in Last Month	>_ 4 Days/Week	1.0	
	< 4 Days/Week	3.1	(1.2 - 8.7)†
Unit Training (Miles Run in BCT)	Low Mileage (56 miles)	1.0	
	High Mileage (130 miles)	2.0	(1.0 - 3.5)†

* Unpublished data, study of 303 infantry trainees followed up for 12 weeks of initial entry training.

† p < 0.05

3. PURPOSES/OBJECTIVES. The above review indicates that injury incidence during BCT has been well established and some injury risk factors have been identified. However, much of these data were collected over a decade ago; training and other

factors have changed since this time. Furthermore, previous investigations involved basic training units that were segregated by gender (5, 21, 22, 32) or involved studies of a single gender (24, 49); basic training is now gender-integrated. The present investigation will examine the current injury incidence, injury risk factors, and physical fitness levels in a gender-integrated battalion at Ft Jackson in 1997. Since previous data on injuries and fitness at Ft Jackson are available for the years 1978, 1984 and 1988 (22, 28), a historical perspective will be provided. The study will also identify directions for a more comprehensive investigation of injuries that will be conducted subsequently.

4. METHODS. This study used a retrospective cohort design. The cohort was all trainees in the 2d Battalion, 60th Infantry Regiment (2-60th Infantry Battalion) participating in the 8-week basic training cycle occurring between 24 October 1997 and 17 December 1997 who had a medical record available at the time of the screening. Cases were defined as any trainee in this Battalion who had an injury recorded in his or her medical record. Data were recorded between 11 and 17 December 1997.

a. Data Sources. For this preliminary investigation, we obtained information that was readily available from McWethy Army Troop Medical Clinic (TMC) and 2-60th Infantry Battalion records. This included Platoon Manning Rosters, medical records, alpha rosters, discharge packets, discharge summaries, newstart rosters, and Army Physical Fitness Test (APFT) cards, as described below.

(1) Platoon Manning Rosters (Demographics). The Platoon Manning Roster contained most of the demographic data obtained in this study. This included each trainees' rank, marital status, age, educational level, gender, and race. In addition, Platoon Manning Rosters contained whether or not the individual came from the Fitness Training Unit. All of this information was extracted and coded.

(2) Medical Records (Injury Data) . Whenever a trainee enters the medical system, medical record forms are generated and placed in the trainee medical record. These records are stored at the TMC. For each trainee in the 2-60th Infantry Battalion, we extracted the following data for each visit to a medical care provider: date of visit, duration of symptoms (reported by trainee), diagnosis, body part injured, side of body injured, disposition, and any days of limited duty. This information was typically available on one of three forms: Screening Note of Acute Medical Care (Department of the Army Form 5181-R), Chronology of Medical Care (Standard Form 600) or Emergency Care and Treatment Form (Standard Form 558). Profiles and sick call slips were obtained from each company in the battalion to more fully document the number of limited duty days.

(3) Alpha Rosters, Newstarts, and Discharges.

(a) Alpha rosters were alphabetic listings of trainees kept by each company in the battalion. Alpha rosters dated on the first week of BCT provided the number of trainees at the start of the training cycle. Trainees completing the cycle were obtained by comparing these alpha rosters with alpha rosters dated near the end of training and cross checked with newstart rosters and discharge data.

(b) Newstart data was obtained from summaries provided by the battalion S-3 (Plans, Training, and Operations Section) and coded as to the reason the trainee was newstarted. Newstart-ins were trainees entering the battalion from another battalion because they did not complete mandatory training requirements for a variety of reasons (injury, emergency leave, inability to meet the standard, etc.). They could come into the unit at any point and leave at any point depending on the nature of the required training. Newstart-outs were trainees leaving the 2-60th Infantry Battalion because they could not complete required training. Trainees can only be a newstart once; if they fail to meet a training requirement a second time, they are discharged in accordance with Army Training and Doctrine Command (TRADOC) Regulation 350-6.

(c) Discharge data was obtained from summaries provided by the battalion S-1 (Personnel Section); they were coded as to the nature of the discharge (i.e., soldierization, medical, etc.). When available, discharge packets were reviewed to obtain a more complete picture of why trainees were discharged. Discharge packets contained detailed information, including counseling statements, statements from trainees, relevant medical information, commander's evaluation, etc.

(4) Army Physical Fitness Test (APFT) Data. The first diagnostic APFT was taken in week 1 of BCT and the final APFT was taken in week 6 or 7. The APFT card (Department of the Army Form 705) of each trainee was examined to obtain measures of physical fitness and body habitus. Information extracted included first diagnostic and final raw scores for push-ups, sit-ups, 2-mile run, and total APFT points (1). Body mass (weight) and stature (height) on the first diagnostic APFT test were also obtained. The push-up and sit-up scores were the maximum number that could be completed in separate 2-minute periods. For the 2-mile run, time to complete the distance was recorded.

b. Injury Definitions.

(1) An injury was defined as an energy exchange that resulted in damage to the body (18) for which the trainee visited a medical care provider and the encounter was recorded in the medical record. Injuries could be due to overuse (long-term energy exchanges resulting in cumulative microtrauma) or acute trauma (sudden energy exchanges resulting in sudden, overload trauma). Overuse injuries included musculoskeletal pain (not otherwise specified), stress fractures, stress reactions, tendinitis, bursitis, fasciitis, overuse syndromes, and strains. Traumatic injuries

included sprains, dislocations, fractures, blisters, abrasions, lacerations, and contusions. Stress reactions were defined as musculoskeletal pain for which there was clinical suspicion of a stress fracture, but either no X-ray was obtained or the stress fracture could not be diagnosed on the X-ray. A stress fracture required radiographic confirmation.

(2) A new injury was defined as the first visit to a medical care provider for a specific injury. A follow-up injury was a subsequent visit to a provider for the same injury. Total injuries included new and follow-up injury visits. A day of limited duty was defined as a day in which a physical limitation was prescribed by the medical care provider for the patient (commonly called a profile).

c. Trainee Medical Care.

(1) In order to understand how trainee medical encounters are entered into the medical records, it is necessary to understand the trainee medical care system at Ft Jackson. At the time these data were collected, trainees could enter the medical system either at the training battalion or at the hospital emergency room. Normal sick call is conducted by a medic at the battalion. The medic makes the decision to treat the trainee at the battalion and return the trainee to duty, or refer the trainee to the McWethy Army TMC for further treatment. We analyzed sick call sign-in data from the 2-60th Infantry Battalion from October to December 1997 and found that 38% of trainees were returned to duty and 62% referred to the TMC. For some follow-up visits or injuries outside of sick call, the trainee may report directly to the TMC.

(2) If the TMC is closed, the trainee can obtain medical care at the Moncrief Army Community Hospital Emergency Room. Here, a medic performs an initial screening and either treats and returns the trainee to duty or refers the trainee to a higher level of care.

d. Data Analysis.

(1) Cumulative injury incidence (cases/100 trainees) during the 8 weeks of basic training was calculated by comparing subjects with one or more injuries (numerator) to all other trainees with a medical record (denominator). Injury incidence was defined as those trainees with an injury recorded in the medial record divided by all trainees with a medical record.

(2) To examine risk factors for injury, injury incidence was compared at various levels of each potential risk factor using the Pearson χ^2 statistic to test the hypothesis of no difference between groups. Continuous variables were split into quartiles (based on the subject distribution of that variable), and the incidence of injury was compared

between quartiles using the Pearson χ^2 statistic. Where appropriate, Mantel-Haensel χ^2 for trend was employed.

(3) After completion of the univariate risk factor analysis, logistic regression was used to examine interrelationships among injury risk factors. Independent variables were the potential risk factors, and the dependent variable was the presence or absence of injury. A backward stepwise selection procedure was used with the enter criteria set at $p \leq 0.10$ and exit criteria set at $p \leq 0.15$. Each level of a potential risk factor was compared to a reference level (except the reference level itself) to obtain coefficients and adjusted odds ratios. The reference level was usually the level of lowest injury risk. Confidence intervals were calculated from the estimated regression coefficients and their standard errors (20).

5. RESULTS.

a. Data Collection and Limitations.

(1) Because data was obtained from several different sources, and these sources were not combined until after the data collection was completed, there was missing data on some trainees. For example, there were 799 medical records screened, but gender was obtained on only 731 trainees. This occurred because gender was secured from the demographic records in the battalion, and some demographic data was missing. Demographics were often missing in the case of newstart-ins since most companies obtained this information early in training (some companies did secure demographics of newstart-ins). Some APFT cards were not available, often because the card was in a different location when the data was being extracted.

(2) Another problem was obtaining full data on discharges. We found that once the commander made the decision to discharge an individual, that discharge was completed within 5 days. The full medical record went with the original packet (off post) and were not part of the packet retained in the battalion (although sometimes excerpts of relevant medical problems were part of the packet). Thus, the medical record of most discharges could not be screened. Similarly, newstart-in medical records were often missing because the trainee had graduated or gone on to another unit before the records were screened.

(3) Medical records were obtained on 799 trainees, APFT records on 726, and demographic records on 906. There were 662 trainees with all three data sources obtained (although data in the record was not necessarily complete). When data is reported, it includes all available information for the variables under study.

b. Physical and Demographic Characteristics. Table 3 shows the physical characteristics of the cohort. Age was obtained from the Platoon Manning Rosters and stature and body mass from the APFT cards; thus, the physical characteristics are those of the cohort early in BCT. Body mass index was calculated as body mass/stature² (28). Table 4 shows the demographic characteristics of the trainees obtained from the Platoon Manning Rosters. The cohort was primarily white, single, and with a high school education.

Table 3. Physical Characteristics of the Cohort

	Men			Women		
	N	Mean	SD	N	Mean	SD
Age (yrs)	378	21	4	339	21	3
Stature (cm)	349	176.0	7.7	298	163.6	7.2
Body Mass (kg)	350	77.1	12.9	298	62.1	9.3
Body Mass Index (kg/m ²)	346	24.8	3.9	293	23.2	2.9

Table 4. Demographic Characteristics of the Cohort

Variable	Level of Variable	Men		Women	
		N	Proportion (%)	N	Proportion (%)
Rank	E-1	254	66.0	199	58.7
	E-2	58	15.1	72	21.2
	E-3	37	9.6	43	12.7
	E-4	36	9.4	25	7.4
Ethnicity	White	228	58.9	154	45.2
	Black	90	23.3	131	38.4
	Hispanic	46	11.9	39	11.4
	Other	23	5.9	17	5.0
Marital Status	Single	320	83.1	277	81.7
	Married	60	15.6	62	18.3
	Divorced	5	1.3	0	0
Educational Level	GED	38	9.9	19	5.6
	High School	219	57.0	219	64.6
	1-3 Yrs College	88	22.9	74	21.8
	≥College Grad	39	10.2	27	8.0
Fitness Training Unit	Yes	7	2.3	19	6.9
	No	301	97.7	258	93.1

c. Army Physical Fitness Test Data.

(1) Table 5 shows the first diagnostic and final APFT scores. On the raw scores, improvements for the men ranged from 14% on the run to 55% on the push-ups. For women, improvements ranged from 16% on the run to 150% on the push-ups.

Table 5. First Diagnostic and Final APFT Scores (Means \pm SD)

	Men			Women		
	First Diagnostic	Final	Change (%)	First Diagnostic	Final	Change (%)
Push-Ups (n)	33 \pm 15	51 \pm 14	55	10 \pm 9	25 \pm 10	150
Sit-Ups (n)	40 \pm 14	59 \pm 10	48	33 \pm 15	55 \pm 12	67
Run (min)	17.2 \pm 2.6	14.8 \pm 1.3	14	21.5 \pm 2.8	18.1 \pm 1.4	16
Total Points	147 \pm 50	214 \pm 28	46	108 \pm 52	204 \pm 30	86

(2) In order to pass the APFT, the trainee must achieve a score of at least 50 points on each of the three APFT events. Table 6 shows the 50-point criteria (1). Using these criteria, APFT failure incidence can be calculated for each APFT. On the first diagnostic APFT, male failure incidence for push-ups, sit-ups and the 2-mile run were 40.3%, 46.5% and 41.4%, respectively; female failure incidences were 63.5%, 61.2% and 63.2%, respectively. Overall first diagnostic APFT failure incidence (any single event below the 50 point value) was 67.8% of the men and 87.6% of the women.

(3) Failures on the final APFT were also calculated using the criteria in Table 6. For the men, failure incidences on the final test for push-ups, sit-ups, and the 2-mile run were 0.8%, 0.8% and 2.0%, respectively. For the women, APFT failure incidences were 1.0%, 1.3% and 1.0%, respectively. Overall, APFT failure incidence on the final test was 2.5% of the men and 2.7% of the women.

Table 6. Minimum Standards for Passing APFT Events in BCT (1)

Age Group (yrs)	Men			Women		
	Push Ups	Sit Ups	Run	Push Ups	Sit Ups	Run
17-21	32	42	16.9	13	40	19.9
22-26	30	37	17.6	11	35	20.6
27-31	28	32	18.3	10	30	20.7
32-36	23	28	19.0	9	25	23.6

d. Injuries.

(1) The cumulative incidence of injuries (trainees with one or more injuries) was 15.4% for men and 38.0% for women (risk ratio=2.5, $p<0.001$). A total of 60 men and 130 women experienced one or more injuries. Men had 65 new injuries while women had 158 new injuries. Men had 22 follow-up injury visits and women had 91 follow-up injury visits. For lower extremity overuse injuries, the cumulative incidence was 8.0% for men and 31.0% for women (risk ratio=3.9, $p<0.001$). A total of 31 men and 106 women experienced one or more lower extremity overuse injuries.

(2) Table 7 shows the injuries by diagnosis. By far, the most common diagnosis was pain (not otherwise specified) accounting for 38% of all male new injuries and 50% of all female new injuries. Strains and sprains accounted for 15% of male new injuries and 13% of female new injuries. There were three fractures, all occurring in men. Stress reactions and stress fractures accounted for 5% of new injuries in men and 11% of new injuries in women. Cumulative incidence of stress fractures and stress reactions was 0.8% in men and 5.0% in women.

(3) Table 8 shows the injuries by body part. Lower body injuries accounted for 72% of the male new injuries and 83% of the female new injuries. Upper body injuries accounted for 22% of male new injuries and 13% of female new injuries. The most common site of injury was the knee, accounting for 23% of male new injuries and 26% of female new injuries. Other common injury sites were the foot (11% of the male new injuries and 21% of the new female injuries) and ankle (18% of male new injuries and 11% of female new injuries). Injuries to the knee and below accounted for 62% of male new injuries and 71% of female new injuries.

Table 7. Injuries to Basic Trainees by Diagnosis

		Men (n=389)		Women (n=342)	
		New Injuries (n)	Total Injuries (n)	New Injuries (n)	Total Injuries (n)
OVERUSE	Pain	25	35	79	101
	RPPS*	2	2	9	16
	Fasciitis/Tendinitis/Bursitis	1	1	13	23
	Stress Fractures	1	1	7	17
	Stress Reactions	2	2	11	29
	Other Overuse	6	7	8	11
	Other Musculoskeletal	2	2	0	0
TRAUMATIC	Strains	2	2	8	14
	Fractures	3	4	0	0
	Sprains	8	16	12	25
	Contusions	5	6	4	5
	Abrasions/Lacerations	2	3	2	2
	Blisters	2	2	0	0
	Other Traumatic	4	4	4	6
	Total	65	87	158	248

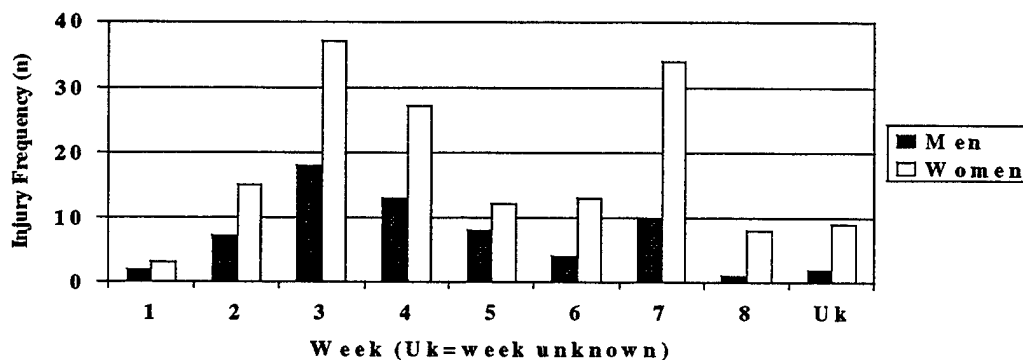
*RPPS= Retropatellar Pain Syndrome

Table 8. Injuries to Basic Trainees by Body Part

		Men			Women		
		New Injuries (n)	Total Injuries (n)	Limited Duty Days (n)	New Injuries (n)	Total Injuries (n)	Limited Duty Days (n)
Upper Body	Head/Face	4	6	3	3	3	3
	Neck	0	0	0	1	2	5
	Chest/Abdomen	3	3	5	2	3	0
	Upper Back	2	3	3	2	2	0
	Shoulder	1	4	8	6	7	25
	Arm	2	2	0	0	0	0
	Hand	1	1	0	1	1	0
	Fingers	1	1	0	4	7	14
Lower Body	Lower Back	4	10	16	10	19	40
	Hip/Pelvis	1	1	3	2	3	10
	Thigh	2	2	7	7	13	45
	Knee	15	20	60	41	72	206
	Calf	0	0	0	3	3	5
	Shin	2	2	0	17	26	99
	Ankle	12	16	47	18	33	129
	Foot	7	8	24	33	46	143
	Toe	4	4	13	0	0	0
Misc.	Multiple Areas	1	1	3	1	1	7
	Unknown/Missing	3	3	3	7	8	51
Total		65	87	202	158	249	782

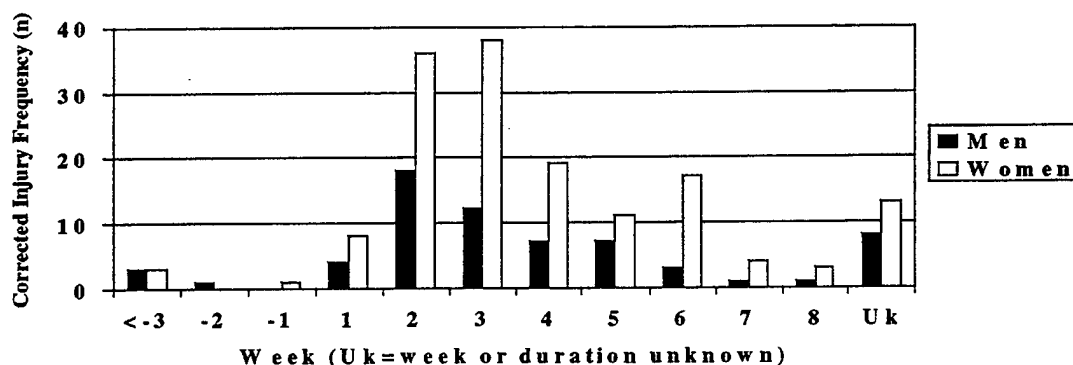
(4) The distribution of new injuries by week of training is shown in Figure 1. The pattern was similar for both men and women. Injury frequency showed a bimodal pattern with peaks in week 3 and week 7 of training. Injury frequency is reported here rather than rates because weekly battalion strength (denominators) was not obtained.

Figure 1. Injuries by Week of Training



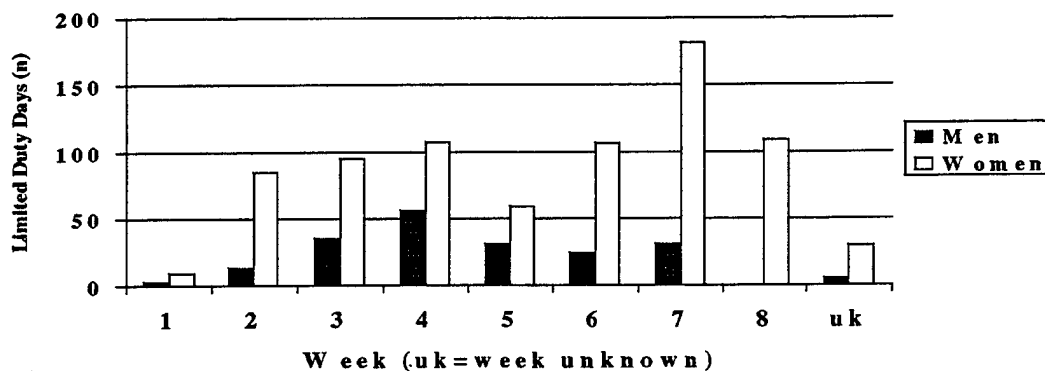
(5) Figure 2 shows the frequency of new injuries by week of onset of symptoms. This was calculated by subtracting the trainee-reported duration of symptoms from the date of the visit. The pattern differs from that seen in the previous figure (which was based on the date of visit alone). Both male and female trainees were more likely to have experienced symptoms early in training, especially in weeks 2 and 3. In some cases, symptoms were prior to entering the battalion (i.e., the negative numbers in Figure 2), presumably in the reception station or prior to entry into the Army.

Figure 2. Injury by Week of Training Corrected for Trainee Reported Duration of Symptoms



(6) Figure 3 shows the number of limited duty days plotted by week of training. The pattern differs for men and women. For men, limited duty days increase to a high in week 4, then decrease. Women follow a similar pattern up to week 4, but a second increase is seen in week 7 with a large number of limited duty days during weeks 6 through 8.

Figure 3. Limited Duty Days by Week of Training



e. Risk Factors for Injuries.

(1) Potential injury risk factors and cumulative injury incidence at various levels of each potential risk factor are shown in Table 9. Female gender was a risk factor since (as noted above) cumulative injury incidence was 15.4% for men and 38% for women (risk ratio=2.5, $p<0.01$).

(2) Among the women, risk factors included age, body mass, body mass index, slower diagnostic run times, training company, and marital status. For the men, risk factors included a low number of diagnostic push-ups or sit-ups, rank, marital status, and educational level. Women in Company C had a lower injury risk than women in other companies (22% vs 43%, $p<0.001$) The relationship of BMI and body mass to injuries differed in men and women. In men, as BMI or body mass increased, injury risk increased; in women, as BMI or body mass increased, injury risk decreased.

(3) Marital status was related to age with older individuals more likely to be married (see Figure 4). When marital status was stratified by age, the incidence of injury was similar in all age groups, with the exception of the men in the oldest age group (Table 10) . Rank was related to educational level in both men and women, with individuals of higher rank more likely to have a higher educational level (see Figure 5). The Spearman rank order correlation between rank and educational level was 0.52 for men ($p=0.04$) and 0.51 ($p=0.05$) for women.

Figure 4. Age and Marital Status

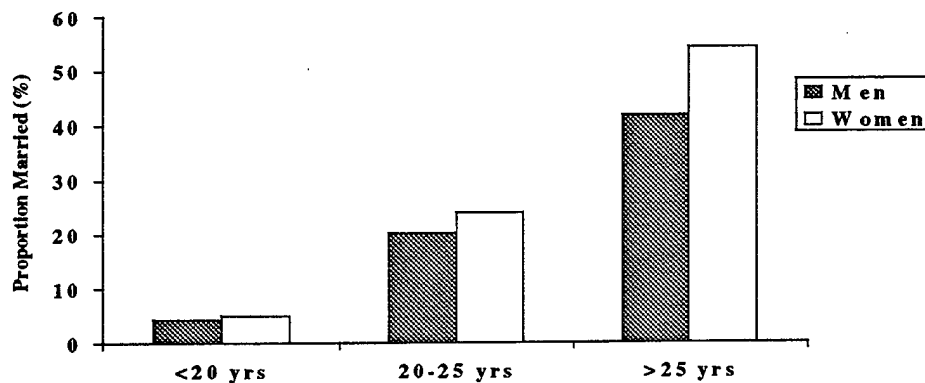


Figure 5. Educational Level and Rank

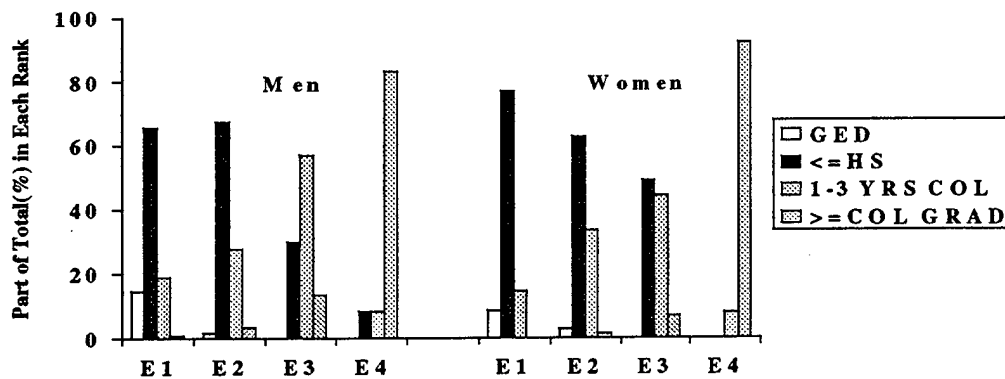


Table 9. Association of Potential Risk Factors with Injury Incidence in Male and Female Basic Combat Trainees

	Men					Women				
	Range	N	Injury Incidence (%)	Chi-Square (p-value)	Chi-square for trend (p-value)	Range	N	Injury Incidence (%)	Chi-Square (p-value)	Chi-square for trend (p-value)
Age	<20 20-25 >25 (yrs)	218 117 43	13.3 16.2 20.9	0.41	0.18	<20 20-25 >25 (yrs)	205 97 37	31.2 46.4 51.4	0.01	<0.01
Stature	57-67 68-69 70-71 72-77 (in)	92 88 100 69	16.3 9.1 20.0 11.6	0.16	0.96	53-62 63-64 65-66 67-72 (in)	73 87 78 60	41.1 26.4 42.3 31.7	0.11	0.73
Body Mass	106-148 149-167 168-188 189-255 (lbs)	87 91 83 89	11.5 13.2 14.5 19.1	0.52	0.15	95-122 123-134 135-149 150-202 (lbs)	74 73 72 79	43.2 34.2 34.7 29.1	0.33	0.09
Body Mass Index	17.11-21.90 21.93-24.40 24.41-27.18 27.23-47.04 (kg/m ²)	84 86 88 88	10.7 14.0 15.9 18.2	0.56	0.15	16.98-20.83 20.91-23.21 23.23-25.06 25.07-36.05 (kg/m ²)	73 73 75 72	38.4 42.5 32.0 27.8	0.25	0.09
First Diagnostic Push Ups	0-22 23-33 34-43 44-82 (reps)	92 89 85 85	18.5 18.0 10.6 9.4	0.18	0.04	0-3 4-8 9-14 15-45 (reps)	72 69 82 76	33.3 34.8 35.4 36.8	0.98	0.65
First Diagnostic Sit Ups	5-53 54-59 60-65 66-68 (reps)	85 93 87 86	17.6 15.1 13.8 10.5	0.60	0.08	5-47 48-54 55-62 63-98 (reps)	78 70 76 75	34.6 34.3 32.9 38.7	0.89	0.67
First Diagnostic Two-Mile Run	20.43-15.70 15.72-14.83 14.82-13.93 13.97-11.58 (min)	88 85 85 84	17.0 11.8 15.3 14.3	0.80	0.77	22.97-19.07 19.08-18.33 18.35-17.35 17.38-13.50 (min)	69 74 72 77	44.9 35.1 31.9 31.2	0.30	0.08
Training Company	A B C D E	71 76 88 76 78	15.5 11.8 22.7 15.8 10.3	0.20	—	A B C D E	62 56 79 78 67	38.7 42.9 21.5 44.9 44.8	0.02	—
Rank	E-1 E-2 E-3 E-4	254 58 37 36	17.3 13.8 13.5 5.6	0.31	0.07	E-1 E-2 E-3 E-4	199 72 43 25	36.2 44.4 34.9 36.0	0.62	0.91
Marital Status	Single Married	320 60	12.8 25.0	0.02	—	Single Married	277 62	35.4 48.4	0.06	—
Education Level	GED High School 1-3 yrs College ≥College Grad	38 219 88 39	23.7 15.1 17.0 5.1	0.15	0.08	GED High School 1-3 yrs College ≥College Grad	19 219 74 27	42.1 36.1 40.5 40.7	0.86	0.65
Ethnicity	White Black Hispanic Other	228 90 46 23	15.8 15.6 15.2 13.0	0.99	—	White Black Hispanic Other	154 131 39 17	31.8 44.3 38.5 41.2	0.19	—

Table 10. Marital Status Stratified by Age

Age (yrs)	Men				Women			
	Married Injury Incidence (%)	Single Injury Incidence (%)	RR*	p- value	Married Injury Incidence (%)	Single Injury Incidence (%)	RR*	p- value
<20	26.6	12.4	2.2	0.22	25.0	33.0	0.8	0.22
20-25	18.2	13.1	1.4	0.45	50.0	36.4	1.4	0.16
<25	35.0	14.3	2.5	0.10	55.0	47.1	1.2	0.63

* RR=Risk Ratio (married/single)

(4) Logistic regression was used to determine which risk factors had the highest associations with injuries and to control for interrelationships among risk factors. Candidates for the analyses included age, stature, body mass, BMI, and diagnostic push-ups, sit-ups and 2-mile run. Separate models were developed for men and women. Final models were based on 328 men and 283 women with complete data. Table 11 shows the adjusted odds ratios and confidence intervals for the factors remaining in the model after the backward stepwise procedure. For men, two factors had odds ratios greater than baseline: age greater than 25 years and push-ups less than 33 repetitions on the diagnostic APFT. For women, there were four factors with odds ratios greater than baseline: age greater than 25 years, BMI less than 23.1 kg/m², 2-mile run times greater than 19.1 minutes on the diagnostic APFT, and stature between 63 and 64 inches.

Table 11. Logistic Regression Results from Backward Stepping Procedure with Injury Incidence as the Independent Variable

Men			Women		
Variable	Adjusted Odds Ratio	95% Confidence Interval	Variable	Adjusted Odds Ratio	95% Confidence Interval
Age			Age (yrs)		
<20	1.0	---	<20	1.0	---
20-25	1.4	0.7-2.8	20-25	1.4	0.8-2.4
>25 (yrs)	2.9	1.1-7.1	>25 (yrs)	2.8	1.2-6.8
Stature			Stature		
57-67	1.0	---	53-62	1.0	---
68-69	2.2	0.9-5.7	63-64	2.2	1.0-4.5
70-71	1.1	0.5-2.3	65-66	1.1	0.5-2.1
72-77 (in)	2.5	0.9-7.0	67-72 (in)	1.3	0.6-2.9
Push-Ups			BMI		
44-82	1.0	---	36.05-25.07	1.0	---
34-43	1.4	0.5-4.0	23.06-25.06	1.1	0.5-2.4
23-33	2.5	1.0-6.6	20.91-23.21	2.4	1.1-5.1
0-22 (reps)	3.1	1.2-8.0	16.98-20.82 (kg/m ²)	2.1	0-4.4
			Run Time		
			13.50-17.38	1.0	---
			17.35-18.35	1.2	0.6-2.5
			18.33-19.08	1.7	0.8-3.4
			19.07-22.97 (min)	2.3	1.1-4.9

f. Other Adverse Training Outcomes. Other adverse training outcomes included newstarts and discharges. Reasons for trainees becoming a newstart or discharge were examined. A separate analysis of injuries was performed in these subgroups to see if there were any differences in injury incidence.

(1) Newstarts.

(a) There were 109 newstart-ins. Ninety (83%) of these graduated and 19 (17%) did not. Reasons for newstarting are shown in Table 12. The most common reason was an APFT failure (66 of 120 cases or 61%) or an APFT failure with another problem (16 of 120 cases or 13%). The most common reason for a newstart-in failing to graduate (and consequently being discharged) was an APFT failure (13 of 19 cases or 68%) or an APFT failure and another problem (4 of 19 cases or 21%). There were 23 newstart-ins (21%) that had medical problems.

Table 12. Reasons for Newstart-ins and Number Graduating and Not Graduating

Reason for Newstart	Graduated (N)	Did Not Graduate (N)
APFT	53	13
Basic Rifle Marksmanship	7	0
Mandatory Training*	1	0
Field Training Exercise	1	0
APFT & Basic Rifle Marksmanship	1	0
APFT & Mandatory Training	13	4
APFT & Field Training Exercise	2	0
Basic Rifle Marksmanship & Mandatory Training	10	2
Not Specified	2	0
Totals	90	19

* This indicates trainees missed critical phases of training (e.g., confidence course, live fire, etc.).

(b) There were 33 newstarts-out. Seven of the newstart-outs-(21%) were for injuries and were sent to the Physical Training and Rehabilitation Platoon. Twenty-one cases (64%) were for APFT failures, two were for missing the Field Training Exercise (FTX), and three were for other reasons not specified in the record.

(2) Discharges. There were 120 trainees that were discharged from the battalion. Ninety-one of these (76%) were discharged under Army Regulation 635-200 (Personnel Separations, Enlisted Personnel), Chapter 11 (Entry Level Performance and Conduct). Solders discharged under Chapter 11 could not adapt to military service because of a lack of motivation, discipline problems, or inability to satisfactorily complete mandatory training. We reviewed 68 of the 91 Chapter 11 discharge packets (75%). We found that 32 of the 68 cases (47%) included an APFT failure; in 10 of these cases, it was difficult to separate the motivational/emotional elements from the APFT failure; in 4 cases, injuries were associated with the APFT failure, and the trainee refused to become a newstart or to join the Physical Training and Rehabilitation Platoon. Twenty-eight of the 120 trainees (23%) were discharged for medical reasons that existed prior to service. One trainee requested discharge for homosexuality.

(3) Injuries in Newstarts and Discharges. Among the cohort (trainees with medical records), there were 31 newstart-ins, 9 newstart-outs, and 9 discharges. Table 13 shows injury incidence for each type of trainee. There were only 10 newstart-ins for which gender was obtained (because many newstarts came into the unit after much of the demographic data had been recorded by the battalion). While the numbers were small, there was a strong tendency for both male and female newstart-ins to be injured more often than trainees who were not newstart-ins.

Table 13. Injuries in Newstarts and Discharges

		All			Men			Women		
		N	Injury Incd*	Chi-Square (p-Value)	N	Injury Incd* (%)	Chi-Square (p-Value)	N	Injury Incd* (%)	Chi-Square (p-Value)
Newstart-in	No	754	26.1	<0.01	384	15.1	0.13	337	37.4	0.05
	Yes	32	48.4		5	40.0		5	80.0	
Newstart-out	No	777	26.9	0.24	383	15.1	0.22	339	37.8	0.32
	Yes	9	44.4		6	33.3		3	66.7	
Discharge	No	777	26.9	0.50	385	15.6	0.39	339	37.5	0.03
	Yes	9	37.5		4	100		3	100.0	

* Incd=Incidence

g. Injuries in Trainees Coming From Fitness Training Units (FTU). There were records of 26 trainees who came from the FTU into the 2-60th Infantry Battalion (7 men, 19 women). Data on the FTU was often missing from the demographic records because some platoons recorded these data but others did not. Among men from the FTU, cumulative injury incidence was 28.6% during BCT compared to 15.3% for those who did not come from the FTU ($p=0.28$). Among the women from the FTU, cumulative injury incidence was 36.8% during BCT compared to 36.8% for women who did not come from the FTU ($p=0.99$).

h. Company Personnel Status. Table 14 shows the number of trainees at the start of the training cycle (initial strength), the number graduating (final strength), and the number of discharges and newstarts. Total battalion initial strength was 874 trainees and 13.7% of the initial strength were discharged. Final strength includes only trainees graduating with the battalion. Some newstarts came into the company for only a short period to complete required training and left before battalion graduation.

Table 14. Company Personnel Status (Number of Trainees)

Company	A	B	C	D	E
Initial Strength	161	170	185	186	172
Final Strength	160	166	168	158	170
Newstarts-in	41	33	3	6	26
Newstarts-out	10	7	4	8	4
Discharges	31	23	15	28	23
Unaccounted	0	1	0	1	0

6. DISCUSSION. The purposes of this preliminary survey were to determine current injury rates, risk factors for injuries, physical fitness of trainees, and provide direction for a more comprehensive investigation in the future. In relation to past investigations of injuries in basic training, there are three major findings. First, injury incidence is lower than that seen in any other basic training study. Second, risk factors for injury differed for men and women but there are similarities to risk factors found in other investigations. Third, entry level physical fitness of new trainees appears to be lower than trainees of previous years but fitness improvements gained during BCT are similar to those of past years. Each of these major findings is discussed below.

a. Injuries

(1) Table 15 shows cumulative injury incidence in studies that have examined 8-week basic training cycles. The present survey found a cumulative injury incidence lower than any over the last 20 years. The fact that all of these studies were conducted using the same methods suggests the findings are not an artifact. It is possible that injury rates have been declining at all basic training posts over time. However, the unpublished data in Table 16 suggests this is not the case. Table 16 displays BCT injury data for soldiers entering advanced individual training (AIT) for medical specialist (91B) at Ft Sam Houston, Texas during a single training cycle. These data were collected using the same methods as the present study. Although the numbers are small, the data indicate that injury incidence is lower at Ft Jackson than at the second BCT post.

Table 15. Cumulative Incidence of Injuries Among Army Trainees During 8 Weeks of Basic Combat Training

Study	Year Data Collected	Incidence for Men ¹	Incidence for Women*
Kowal (32)	1978	26%	54%
Bensel et al. (5)	1982	23%	42%
Jones et al. (21)	1984	28%	50%
Bell (3)	1988	27%	57%
Westphal et al. (49)	1994	ND†	67%
Present Study	1997	15%	38%

* Cumulative incidence (risks) of injury during 8-week basic combat training cycle

† ND=No data collected

Table 16. BCT Injury Incidence for Soldiers Attending Medic AIT from Different BCT Posts (Unpublished Data, Henderson and Knapik, 1996)

	Men			Women		
	N	Injury Incidence (%)	Chi-square p-value	N	Injury Incidence (%)	Chi-square p-value
Ft Jackson, SC	85	4.7	<0.01	49	20.4	<0.01
Post 2	222	37.8		179	62.0	

(2) The reasons for the lower injury incidence at Ft Jackson is not clear, but several hypotheses were developed during discussions with the 1st and 4th BCT Brigade Commanders, 2-60th Infantry Battalion staff, hospital and clinic personnel, and others individuals with trainee experience. First, it is most likely that the frequency of BCT activity or methods of training have changed in some way that reduces injuries. For example, it has been demonstrated that reducing the number of miles run during physical training (PT) reduces injuries while still improving fitness to a level similar to a more frequent program (23, 40, 44, 45). In the present study, the relative changes in fitness were similar to that seen in the past indicating that the training was achieving similar fitness improvements (see last paragraph of section entitled "Historical Trends in Physical Fitness" below). We did not keep a log of actual training mileage, so we do not know if running mileage had been reduced relative to past years or other training posts. The 2-60th Infantry Battalion staff told us that total running distance was about 60 miles, a level previously shown to reduce injuries while still improving fitness (23).

(3) In addition to the possibly reduced running mileage, the brigade and battalion command staffs told us of other training practices that may have been important in reducing injuries. Physical training was introduced very gradually. Early in training, running often covered a distance of a half mile or less and could involve a combination of running and walking. Running was only done every other day (rather than every day) and in 3 or 4 "ability groups." Ability groups were set up so that the slowest runners were in one group, the fastest in another, and intermediate speed runners in the middle. Finally, Ft Jackson had an FTU that required trainees to meet minimal fitness standards in the Reception Station before they began regular basic training. The additional time spent in the FTU may have resulted in a higher level of fitness level once the trainee did enter BCT. Faster run

times and a greater number of push-ups have been associated with fewer injuries in BCT (7, 21, 24).

(4) Another possible explanation for the low injury incidence may be the fact that we did not obtain complete data on newstarts or discharges. However, the other basic training studies that report higher injury rates than those found here (Table 15) either specifically stated that discharges were not followed (21, 32), or it is not clear if discharges were examined (3, 5, 49). Thus, the lack of follow-up on the discharges (and newstarts) is not a likely explanation of the low injury incidence. In our study, medical records were obtained on only 19% (49 of 262) of newstarts and discharges. Battalion records indicate that only about 20% of these trainees had medical problems, but the battalion lists only serious medical problems, not all sick call visits. It is possible that overall injury incidence is higher in these subgroups (newstarts and discharges) and efforts must be made to obtain more complete data in the future.

(5) A third possible explanation for the lower injury incidence may be recent changes in the enforcement of BCT standards and requirements. Beginning in October 1997, the number of mandatory requirements to graduate from basic training increased from 4 to 12. Previous requirements were to pass Basic Rifle Marksmanship, pass the APFT (50 point level), complete the hand grenade range, and pass the end-of-cycle Individual Proficiency Test (i.e., tests of common soldiering tasks such as recognizing and reacting to nuclear, biological, chemical hazards, land navigation, first aid, rifle function tests, etc.). The new requirements include the previous four in addition to successful completion of 4 road marches, the Victory Tower (a high tower with obstacles), the bayonet course and pugil training, the confidence course (a ground level obstacles course), gas chamber training, Individual Tactical Training, the Infiltration Course, and the FTX (also called Victory Forge). It would be expected that these additional requirements would increase injury risk due to the additional physical exposure. However, this may also have had a reverse effect. Trainees may have delayed seeking medical care for some (presumably minor) injuries in order to complete training requirements. These injuries may have been self-limiting and healed before the trainee sought formal medical care.

(6) Partial support for this latter hypothesis is provided by examining the two graphs showing the distribution of injury by week and the distribution of injuries by week corrected for duration of symptoms (Figures 1 and 2). While the dates of visits for injuries peak in weeks 3 and 7, the majority of symptoms are experienced in weeks 1 to 4. This suggests that trainees experienced symptoms early in training and delayed going to the medical treatment facility until later. Week 7, after the completion of the FTX, may have been a popular time to seek medical care because all basic training requirements were completed and trainees were assured of graduation. While this observation supports the idea that the new training requirements are causing trainees to delay treatment, it should

also be remembered that no previous study has corrected injury visit dates for duration of symptoms; this pattern could have existed before the added training requirements were imposed. Further, the duration of symptoms is self-reported and may be subject to some inaccuracy because of recall problems.

b. Injury Risk Factors.

(1) Since this was a preliminary study, the injury risk factors obtained here were those that could be secured easily from the battalion without disrupting the training schedule. We found similarities with past studies. Women were much more likely to get injured than men, suffering a 2.5-fold higher cumulative injury incidence, and confirming the results of all other investigations of basic training injuries (3, 5, 21, 32, 49). Older age was a significant risk factor for women, and trends were similar for men, indicating that individuals over age 25 years were at elevated risk of injury. This is consistent with most other studies (6, 15, 24) although a study of a single company of female trainees (n=165) found no association between injuries and age (49). It is interesting that in previous studies of infantry soldiers and mixed groups of soldiers with many different occupational specialties, there is a declining trend of injuries with increasing age (27, 47). This discrepancy between trainees and soldiers may be explained by differences in physical activity. Basic trainees all engage in essentially the same type of physical training regardless of age. On the other hand, in operational U.S. Army units, older soldiers tend to be of higher rank and consequently tend to be in staff or supervisory positions; they may have less exposure to the physical hazards associated with their occupations, compared to younger soldiers.

(2) Another injury risk factor was body mass index (BMI). BMI serves as an index of adiposity since it is highly correlated with both percent body fat and total body fat (22, 28, 43). In the present study, the relationship between BMI and injuries differed by gender: injury risk increased with BMI in men and decreased with BMI in women. Past studies of basic trainees at Ft Jackson have not found a consistent relationship (22). Among male trainees in 1984, higher injury risk was found at higher BMI levels (as we found here), but there was no relationship in 1988. Among female trainees in 1984, individuals in both high and low BMI groups were at elevated risk, but in 1988, risk was elevated in groups of women with lower BMI values (as we found here). Percent body fat (estimated from either skinfolds or circumferences) generally followed these same patterns (22). In order to determine if body fat is associated with injury, it will be necessary to use more definitive methods for determination of body fat such as densitometry or dual energy X-ray absorptiometry (42).

(3) Important components of health-related physical fitness include cardiorespiratory endurance, muscle strength, muscle endurance, flexibility, and body composition (8, 37). The APFT measures three of these components, muscular strength

and muscular endurance (push-ups and sit-ups) and cardiorespiratory endurance (2-mile run) (26). In this study, a lower level of physical fitness was an injury risk factor, but gender determined the specific fitness components increasing injury likelihood. For the men, this was a lower number of push-ups or sit-ups; for women, slower run times.

(4) Low cardiorespiratory endurance, measured by running performance (run times), is one of the most consistently documented risk factor for injuries in basic trainees (2, 21, 24, 49) as well as infantry and combat engineers (27, 41). This observation makes sense given the ubiquitous nature of weight bearing training (running and marching) in the Army. Individuals with low aerobic capacity will experience greater physiological stress at any given absolute level of performance, and this added stress could result in injury through a wide variety of mechanisms (changes in gait during fatigue, greater musculoskeletal stress, etc.). It is not clear why men did not show a relationship between injuries and 2-mile run times in the present study. It may be that the cadre at Ft Jackson has found the threshold of weight-bearing training at which injuries are minimized and average fitness is optimized.

(5) Push-ups have previously been associated with injuries in male basic trainees (21, 24) but not with women (2, 21, 49), suggesting upper body strength may be a gender specific risk factor for men. Because men have almost twice the upper body strength of women (30, 34), they may be more likely to use their upper body during physical activity. In the present study, upper body injuries made up a greater proportion of injuries in men (22%) than in women (13%); a similar gender-specific injury distribution has been reported previously (21). No previous investigation of basic trainees has demonstrated an association between injuries and sit-ups in male or female trainees.

(6) Marital status was associated with higher risk of injury in both men and women: married trainees were at greater injury risk than single trainees. Older individuals were also more likely to be married, so age may have confounded this relationship as shown in Table 10.

(7) Both rank and educational level were associated with injuries, but trainees entering the Army with more education are often given high rank. Thus, educational level confounded the relationship between rank and injuries. A more interesting question was why those with college degrees were at lower injury risk. This is not clear. It is not due to higher fitness levels or the older age of the college graduates. When a one-way analysis of variance was used to compare APFT scores between educational levels, there were no differences for men ($p \leq 0.22$) or women ($p \leq 0.51$) on any APFT event. Those with college degrees were also likely to be older than those in other educational levels (for men, 21 vs 26 years, $p < 0.01$; for women, 20 vs 25 years, $p < 0.01$), and this would be expected to increase injury likelihood. Possible reasons why individuals with higher educational levels

are at lower risk will require additional study, and the finding will require additional confirmation.

c. Other Adverse Training Outcomes.

(1) Newstarts and Discharges.

(a) APFT failures were the most common reason for newstarting, accounting for 79% of the newstart-ins and 64% of the newstart-outs. Medical problems were a less common reason for newstarting but still accounted for about 21% of both types of newstarts.

(b) Examining available discharge packets revealed that in 23% of cases trainees were discharged for medical reasons that existed prior to service. This is a higher incidence than the 15% reported by Jones et al. (21) in 1984 at Ft Jackson. A General Accounting Office report on military attrition noted that 3.9% of all enlistees are discharged for medical reasons within the first 6 months of service (14). In the present study, discharges for diagnosed medical conditions amounted to 3.2% of the initial battalion strength (28 discharges for 874 trainees) over the 2 months of basic training.

(c) Chapter 11 discharges (AR 635-200 - Entry Level Conduct and Performance) were often complex and often for more than one reason. Among the Chapter 11 discharges, 47% were associated with an APFT failure. However, a trainee may have shown a lack of discipline and/or motivation and failed the APFT for these reasons rather than a lack of physical capability. As another example, an injury may have been the primary motivation for a trainee's decision to try to obtain a discharge; failing Basic Rifle Marksmanship may have been a way to enable this discharge. We also found some incidence of trainees who were discharged under Chapter 11 for refusing to go to the PTRP. Since these were not specifically coded in the discharge summaries, the number of trainees discharged for medically-related reasons may have been underestimated.

(2) Injuries in Newstarts and Discharges.

(a) Whether injury incidence is different in newstart-outs or discharges is not clear because of the very small amount of data obtained on these individuals. However, newstart-ins do appear to be at greater risk of injury than other trainees. This could be due to longer training times or psychosocial factors as discussed next.

(b) Newstart-ins generally have longer training time than individuals who are not newstarted. The additional training exposure may be the simplest explanation for the increased injury incidence (23, 31). Data to support this supposition come from a comparison of Infantry Basic Training at Ft Benning, Georgia, with regular basic training at Ft Jackson. Infantry Basic Training resulted in a similar monthly injury rate when

compared to regular basic training (14 vs 15 injuries/100 trainee months). However, infantry basic training is 4 weeks longer and had a greater cumulative injury incidence than regular BCT (27% vs 46%) (3, 21, 24). Thus, the additional exposure to training may account for the higher likelihood of injury in newstarts.

(c) An alternative explanation for why newstarts-ins are more often injured may relate to psychosocial factors. Newstarts-ins must adjust to stressors in the new training environment that differ from those in their previous environment (e.g., changes in drill sergeants, training schedules, barracks, and the like). New life stressors have been shown to increase injury incidence in active individuals (19, 36, 48). In addition, newstart-ins lose the social support network (other trainees) they have established in their previous platoons. While BCT is purposefully stressful, it has been shown that lack of social support when faced with new life stress results in an exacerbation of injuries and illnesses (35, 39). The relationship between stress and social support is complex because more self-reliance and greater coping skills appear to further modify these relationships (13, 46). Further study of this phenomena using simple questionnaire techniques might result in useful approaches for reducing injuries in newstarts.

d. Historical Trends in Physical Fitness.

(1) Entry level fitness of the male and female trainees at Ft Jackson in 1997 appears to be lower than that seen historically. Table 17 shows data from four studies (present one included) that examined physical characteristics and physical fitness of male trainees at Ft Jackson from 1978-1997. Both body mass (weight) and stature (height) have increased slightly but body mass more than stature, so that BMI increased 7%. The changes in the number of push-ups trainees completed on entry have been small, increasing about 3 repetitions from 1984 to 1997. However, sit-ups declined over this same period, with an average of 15 fewer repetitions performed. For the 2-mile run, new trainees completed the distance 48 seconds slower from 1988 to 1997.

(2) The decline in women's fitness was similar to that of men as shown in Table 18. While stature has not changed substantially, body mass increased, resulting in a 4% increase in BMI. Interestingly, there was little change in BMI from 1978 to 1988 but all the body mass gain was seen from 1988 to 1997. Performance on all three APFT events has declined over the period. From 1984 to 1997 this amounted to only a modest 2 repetitions on the push-ups, but a larger 13 repetitions on the sit-ups. Over the 9-year period from 1988 to 1997, the decline in 2-mile running performance was 1.2 minutes.

Table 17. Physical Characteristics and Physical Fitness of Male Trainees on Entry to Basic Training at Ft Jackson at Various Times (Values are Means \pm SD)

	N	Age (yrs)	Stature (cm)	Weight (kg)	Body Mass Index (kg/m ²)	Push-ups (n)	Sit-Ups (n)	Two-Mile Run (min)
1978 (28)	949	21	174.3	70.7	23.2 \pm 3.1	ND*	ND*	ND*
1984 (22)	124	20 \pm 3	175.2 \pm 6.6	73.6 \pm 10.9	24.3 \pm 3.1	31 \pm 9	55 \pm 14	†
1988 (22)	1056	20 \pm 3	175.2 \pm 7.1	75.7 \pm 12.2	24.6 \pm 3.6	31 \pm 13	44 \pm 12	16.4 \pm 2.2
1997 (Present)	389	21 \pm 4	176.0 \pm 7.7	77.1 \pm 12.9	24.8 \pm 3.9	33 \pm 15	40 \pm 14	17.2 \pm 2.6

* ND=No data collected

† 1-mile run administered in 1984 (7.6 \pm 0.9 min)

Table 18. Physical Characteristics and Physical Fitness of Female Trainees on Entry to Basic Training at Ft Jackson at Various Times (Values are Means \pm SD)

	N	Age (yrs)	Stature (cm)	Weight (kg)	Body Mass Index (kg/m ²)	Push-ups (n)	Sit-Ups (n)	Run (min)
1978 (28)	501	22	162.4	58.9	22.3 \pm 2.4	ND*	ND*	ND*
1984 (22)	186	21 \pm 4	163.3 \pm 6.6	58.7 \pm 5.8	22.4 \pm 2.0	12 \pm 10	40 \pm 12	†
1988(22)	921	20 \pm 4	162.0 \pm 6.5	58.3 \pm 6.5	22.2 \pm 2.0	10 \pm 7	34 \pm 14	20.3 \pm 2.3
1997	342	21 \pm 3	163.6 \pm 7.2	62.2 \pm 9.3	23.2 \pm 2.9	10 \pm 9	33 \pm 15	21.5 \pm 2.8

* ND=No data collected

† 1-mile run administered in 1984 (9.7 \pm 1.4 min)

(3) The decline in pre-entry fitness may be partly attributed to declines in pre-entry physical activity among American youth. The Centers for Disease Control and Prevention

conducted the Youth Risk Behavior Survey in 1992 and 1995. This survey indicated that daily attendance at high-school physical education classes was reduced from 42% in 1992 to 25% in 1995. Students who reported being physically active for at least 20 minutes during their physical education classes declined from 81% to 70%. The percentage of high school students who reported walking or bicycling for 30 minutes or more on 5 or more days preceding the survey declined from 24% in 1992 to 21% in 1995 (9).

(4) There are few historical data in the general population with which to compare the APFT scores or BMI values. Kuntzleman and Reiff (33) report that from 1980 to 1989, 1-mile run times of 14-17 year old boys decreased by 12% and that of 14-17 year old girls by 8%. This suggests that cardiorespiratory fitness declined in this time, in agreement with our data. Corbin and Pangrazi (10) compared youth (6 to 17 year olds) fitness scores from 1975 to 1985 using the National School Physical Fitness Survey results. However, the test items did not include any event used in the APFT. There is evidence that fatness (measured by skinfolds) is increasing in youth, in consonance with the BMI data here (17, 33).

(5) The relative improvements in fitness during BCT were similar in 1988 and 1997. Table 19 shows the changes in fitness in 1988 and 1997 as measured by comparing first diagnostic and final APFT raw scores (final APFT data were not collected in 1984). With the exception of sit-ups for the women, the relative changes in the 2 years are similar, suggesting the both training programs achieved similar fitness levels given the different starting levels.

Table 19. Absolute and Relative Changes in APFT Scores of Male and Female Trainees at Ft Jackson 1988 and 1997

APFT Event	Year	Men		Women	
		Absolute Change	Relative Change (%) [*]	Absolute Change	Relative Change (%) [*]
Push-ups	1988	20 reps	65	18 reps	180
	1997	18 reps	55	15 reps	150
Sit-ups	1988	20 reps	45	27 reps	79
	1997	19 reps	48	22 reps	40
2-mile Run	1988	-2.3 min	16	-2.8 min	14
	1997	-2.4 min	14	-3.4 min	16

- Calculated relative to the initial fitness level ((final-initial)/initial X 100%).

7. CONCLUSIONS AND RECOMMENDATIONS. This was a preliminary survey in preparation for a more comprehensive one. Recommendations for the next investigation are as follows.

a. Confirm the low incidence of injuries documented at Ft Jackson in this report. The evolution of training practices over the years may account for the lower injury incidence.

b. Observe basic training activities to see if various training activities can be related to injury incidence.

(1) Keep a log of the actual number of daily miles that each company traverses. This should include the number of miles run, miles marched to and from training, and miles in road marching. Injuries can then be examined to see if they are related to various aspects of locomotion.

(2) Observe other aspects of BCT (physical training, APFT tests, Victory Tower, pugil training, confidence course, etc.) to see if these are associated with injuries.

(3) Instrument a small number of trainees in each company with devices (e.g., accelerometers, foot strike monitors) so that the total number of footsteps taken during the course of a day can be recorded. Obtain loads carried by soldiers during marches.

c. Obtain complete medical records on discharges and newstarts. Newstart-ins had higher injury risk but given the small sample size, this relationship requires further confirmation. Based on preliminary contacts, complete medical records reviews can be achieved by working with the Medical Records Section, McWethy Army Medical Clinic and the Trainee Discharge Detachment at Ft Jackson to assure medical records are reviewed before they leave Ft Jackson.

d. Obtain more definitive measures of physical fitness and relate these to injury incidence. Physical fitness was demonstrated to be a risk factor in this investigation and has been reported in many other investigations of basic training. However, measures obtained (BMI, push-ups, sit-ups, 2-mile run) are field standards that should be confirmed with more definitive measures. These definitive measures should include VO_2 max to measure cardiorespiratory endurance, one repetition maximums on a variety of muscle groups to measure muscular strength, and densitometry or dual energy X-ray absorptiometry to measure body composition.

e. Obtain more physiologically accurate measures of physical fitness and compare entry and final levels to data collected in 1978 (30, 38). This will allow a more accurate comparison of fitness over a longer period of time and with more definitive measures than the APFT data presented in this report.

f. Examine physical activity levels of trainees prior to entry. The lower levels of physical fitness may be due to lack of activity, as indicated by civilian surveys conducted by the Centers for Disease Control and Prevention. Also, previous data on physical activity exists from Ft Jackson in 1988 so direct comparisons can be made.

JOSEPH KNAPIK
Research Physiologist
Epidemiology Program

APPROVED:

JOSE SANCHEZ
COL, MC
Manager, Epidemiology Program

APPENDIX A

BIBLIOGRAPHY

1. U.S. Army. Physical Fitness Training. U.S. Army Field Manual (FM) 21-20. Washington, D.C.: Headquarters, Department of the Army, 1992.
2. Bell, N.S. Injury etiology and prevention: selected topics. Harvard School of Public Health Master's Thesis 1994.
3. Bell, N.S., T.W. Mangione, D. Hemenway, P.J. Amoroso and B.H. Jones. High injury rates among female Army trainees: a function of gender. U.S. Army Research Institute of Environmental Medicine Technical Report No. MISC96-6, 1996.
4. Benseel, C.K. The effects of tropical and leather combat boots on lower extremity disorders among U.S. Marine Corps recruits. Natick Massachusetts: U.S. Army Natick Research and Development Command Technical Report No. 76-49-CEMEL, 1976.
5. Benseel, C.K. and R.N. Kish. Lower extremity disorders among men and women in Army basic training and effects of two types of boots. Natick, Massachusetts: U.S. Army Natick Research and Development Laboratories Technical Report TR-83/026, 1983.
6. Brudvig, T.G.S., T.D. Gudger and L. Obermeyer. Stress fractures in 295 trainees: a one year study of incidence as related to age, sex, and race. *Military Medicine* 148:666-667, 1983.
7. Canham, M.L., J.J. Knapik, M.A. Smutok, and B.H. Jones. Training, physical performance, and injuries among men and women preparing for occupations in the Army. In Kumar S (ed) *Advances in Safety and Ergonomics*, Vol 10. Santa Monica: Human Factors and Ergonomics Society, 1998.
8. Caspersen, C.J., K.E. Powell and G.M. Christenson. Physical activity, exercise and physical fitness: definitions, and distinctions for health related research. *Public Health Reports* 100:126-131, 1985.
9. Centers for Disease Control and Prevention. Physical Activity and Health. A Report of the Surgeon General. U.S. Department of Health and Human Services 1996.
10. Corbin, C.B. and R.P. Pangrazi. Are American children and youth fit? *Research Quarterly for Exercise and Sport* 63:96-106, 1992.

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

11. Cowan, D.N., B.H. Jones, P.N. Frykman, P. D.W, E.A. Harman, R.M. Rosenstein and M.T. Rosenstein. Lower limb morphology and risk of overuse injury among male infantry trainees. *Medicine and Science in Sports and Exercise* 28:945-952, 1996.
12. Cowan, D.N., B.H. Jones and J.R. Robinson. Foot morphologic characteristics and risk of exercise-related injuries. *Archives of Family Medicine* 2:773-777, 1993.
13. Funch, D.P. and J.R. Marshall. Self-reliance as a modifier of the effects of life stress and social support. *Journal of Psychosomatic Medicine* 28:9-15, 1984.
14. General Accounting Office. Military attrition. DOD could save millions by better screening enlisted personnel. General Accounting Office Report No. GAO/NSIAD-97-39, 1997.
15. Gardner, L.I., J.E. Dziados, B.H. Jones, J.F. Brundage, J.M. Harris, R. Sullivan and P. Gill. Prevention of lower extremity stress fractures: a controlled trial of a shock absorbent insole. *American Journal of Public Health* 78:1563-1567, 1988.
16. Giladi, M., C. Milgrom, M. Stein and Others. The low arch, a protective factor in stress fractures. *Orthopedic Reviews* 14:81-84, 1985.
17. Gortmaker, S.L., W.H. Dietz, A.M. Sobol and C.A. Wehler. Increasing pediatric obesity in the United States. *American Journal of Diseases of Childhood* 141:535-540, 1987.
18. Haddon, W. Energy damage and ten countermeasure strategies. *Journal of Trauma* 13:321-331, 1973.
19. Hardy, C.J. and R.E. Riehl. An examination of the life stress-injury relationship among noncontact sports participants. *Behavioral Medicine* 14:113-118, 1988.
20. Hosmer, D.W. and S. Lemeshow. Applied Logistic Regression. New York: John Wiley & Sons, 1989.
21. Jones, B.H., M.W. Bovee, J.M. Harris and D.N. Cowan. Intrinsic risk factors for exercise-related injuries among male and female army trainees. *American Journal of Sports Medicine* 21:705-710, 1993.
22. Jones, B.H., M.W. Bovee and J.J. Knapik. The association between body composition, physical fitness, and injuries among male and female Army trainees. In: B. M. Marriott and J. Grumstrup-Scott (Ed), *Body Composition and Physical Performance* 141-173, 1992.

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

23. Jones, B.H., D.N. Cowan and J.J. Knapik. Exercise, training and injuries. *Sports Medicine* 18:202-214, 1994.

24. Jones, B.H., D.N. Cowan, J.P. Tomlinson, J.R. Robinson, D.W. Polly and P.N. Frykman. Epidemiology of injuries associated with physical training among young men in the Army. *Medicine and Science in Sports and Exercise* 25:197-203, 1993.

25. Jones, B.H., R. Manikowski, J.R. Harris, J. Dziados, S. Norton, T. Ewart and J.A. Vogel. Incidence of and risk factors for injury and illness among male and female Army basic trainees. United States Army Research Institute of Environmental Medicine Technical Report No. T19/88, 1988.

26. Knapik, J.J. The Army Physical Fitness Test (APFT): a review of the literature.—*Military Medicine* 154:326-329, 1989.

27. Knapik, J.J., P. Ang, K. Reynolds and B. Jones. Physical fitness, age and injury incidence in infantry soldiers. *Journal of Occupational Medicine* 35:598-603, 1993.

28. Knapik, J.J., R.L. Burse and J.A. Vogel. Height, weight, percent body fat and indices of adiposity for young men and women entering the U.S. Army. *Aviation, Space and Environmental Medicine* 54:223-231, 1983.

29. Knapik, J.J., K.L. Reynolds and J. Barson. Influence of antiperspirants on foot blisters following road marching. U.S. Army Research Laboratory Technical Report No. ARL-TR-1333, 1997.

30. Knapik, J.J., J. Wright, D. Kowal and J.A. Vogel. The influence of U.S. Army Basic Initial Entry Training on the muscular strength of men and women. *Aviation Space and Environmental Medicine* 51:1086-1090, 1980.

31. Koplan, J.P., K.E. Powell, R.K. Sikes, R.W. Shirley and C.C. Campbell. An epidemiologic study of the benefits and risks of running. *Journal of the American Medical Association* 248:3118-3121, 1982.

32. Kowal, D.M. Nature and causes of injuries in women resulting from an endurance training program. *American Journal of Sports Medicine* 8:265-269, 1980.

33. Kuntzleman, C.T. and G.G. Reiff. The decline in American children's fitness levels. *Research Quarterly for Exercise and Sport* 63:107-111, 1992.

34. Laubach, L.L. Comparative muscular strength of men and women: a review of the literature. *Aviation, Space and Environmental Medicine* 7:534-542, 1976.

35. McKay, D.A., R.L. Blake, J.M. Colwill, E.E. Brent, J. McCauley, R. Umlauf, G.W. Stearman and D. Kivlahan. Social support and stress as predictors of illness. *Journal of Family Practice* 20:575-581, 1985.
36. Passer, M.W. and M.D. Seese. Life stress and athletic injury: examination of positive versus negative events and three moderator variables. *Journal of Human Stress* 9:11-16, 1983.
37. Pate, R.R. A new definition of youth fitness. *Physician and Sportsmedicine* 11:77-83, 1983.
38. Patton, J.F., W.L. Daniels and J.A. Vogel. Aerobic power and body fat of men and women during Army Basic Training. *Aviation, Space and Environmental Medicine* 51:492-496, 1980.
39. Petrie, T.A. Psychosocial antecedents of athletic injury: the effect of life stress and social support on female collegiate gymnasts. *Behavioral Medicine* 18:127-138, 1992.
40. Pollock, M.L., L.R. Gettman, C.A. Milesis, M.D. Bah, L. Durstine and R.B. Johnson. Effects of frequency and duration of training on attrition and incidence of injury. *Medicine and Science in Sports and Exercise* 9:31-36, 1977.
41. Reynolds, K., J. Knapik, R. Hoyt, M. Mayo, J. Bremmer and B. Jones. Association of training injuries and physical fitness in U.S. Army combat engineers. *Medicine and Science in Sports and Exercise* 26:S219, 1994.
42. Roche, A.F., S.B. Heymsfield and T.G. Lohman. Human Body Composition. Champaign, IL: Human Kinetics, 1996.
43. Roche, A.F., R.M. Siervogel, W.M. Chumlea and P. Webb. Grading body fatness from limited anthropometric data. *American Journal of Clinical Nutrition* 34:2831-2838, 1981.
44. Rudzki, S.J. Injuries in Australian Army Recruits. Part I: decreased incidence and severity seen with reduced running distance. *Military Medicine* 162:472-476, 1997.
45. Shaffer, R.A. Musculoskeletal Injury Project. 43d Annual Meeting of the American College of Sports Medicine, Cincinnati, OH, 1996.
46. Smith, R.E., F.L. Smoll and J.T. Ptacek. Conjunctive moderator variables in vulnerability and resiliency research: life stress, social support and coping skills, and adolescent sport injuries. *Journal of Personality and Social Psychology* 58:360-370, 1990.

47. Tomlinson, J.P., W.M. Lednar and J.D. Jackson. Risk of injury in soldiers. *Military Medicine* 152:60-64, 1987.
48. VanMechelen, W., J. Twisk, A. Molendijk, B. Blom, J. Snel and H.C. Kemper. Subject-related risk factors for sport injuries: a 1-yr prospective study in young adults. *Medicine and Science in Sports and Exercise* 28:1171-1179, 1996.
49. Westphal, K.A., K.E. Friedl, M.A. Sharp, N. King, T.R. Kramer, K.L. Reynolds and L.J. Marchitelli. Health, performance and nutritional status of U.S. Army women during basic combat training. U.S. Army Research Institute of Environmental Medicine Technical Report No. T96-2, 1995.

APPENDIX B

ACKNOWLEDGEMENTS

1. We would like to thank LTC Frederick Kienle, the Commander of the 2d Battalion, 60th Infantry Regiment for his outstanding cooperation, suggestions, and the enthusiasm with which he supported this consultation. The help of the 2-60th's S-3, 1LT Michael Legler, was invaluable. He provided the battalion records for us, calmly and efficiently answered our numerous questions (despite his other duties), and reviewed an early copy of this manuscript. SSG Jariluz Bonilla did an excellent job providing us the medical records and assuring we had adequate facilities to perform the medical records screening. Thanks also to PFC Bailey for help in providing us with information on discharges. LTC Rosemarie Hendrix, MAJ Barry Whiteside, MAJ Charles Solesbee, CPT Christi McGraw, CPT Michael Money, 1LT Don Goss and 1LT Beth Mason offered helpful suggestions.

2. The following individuals were instrumental in preparing this document.

Dr. Joseph J. Knapik [MAJ(R)]*

Ms. Judith Cuthie*

Ms. Michelle Canham*

MAJ William Hewitson*

MAJ Mary Jo Laurin*

Ms. Mary Anne Nee*

LTC Edward Hoedebecke*

LTC Keith Hauret†

COL Dale Carroll†

COL Bruce Jones*

* Directorate of Epidemiology and Disease Surveillance
U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, MD 21010-5422

† Moncrief Army Community Hospital, Ft Jackson, SC

APPENDIX C

DISTRIBUTION LIST

2 Copies to:

Defense Technical Information Center
ATTN: DTIC-DDA
Alexandria, VA 22304-6145

1 Copy to:

Commandant
U.S. Army Physical Fitness School
Ft Benning GA 31905

Office of the Assistant Secretary of Defense (Hlth Affairs)
ATTN: Medical Readiness
Washington, DC 20301-1200

Commander
U.S. Army Medical Research and Development Command
ATTN: SGRD-OP
Fort Detrick
Frederick, MD 21701-5012

Commander
U.S. Army Medical Research and Development Command
ATTN: SGRD-PLC
Fort Detrick
Frederick, MD 20701-5012

Commander
U.S. Army Medical Research and Development Command
ATTN: SGRD-PLE
Fort Detrick
Frederick, MD 20701-5012

Commandant
Army Medical Department Center and School
ATTN: HSHA-FR, Bldg 2840

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

Fort Sam Houston, TX 78236
JCS
Medical Plans and Operations Division
Deputy Director for Medical Readiness
ATTN: RAD Smyth
Pentagon, Washington, DC 20310

HQDA
Assistant Secretary of the Army for Research, Development and Acquisition
ATTN: SARD-T
Pentagon, Washington, DC 20310

HQDA
Office of the Surgeon General (ATTN: DASG-ZA)
5109 Leesburg Pike
Falls Church, VA 22041-3258

HQDA
Office of the Surgeon General
ATTN: DASG-MS
5109 Leesburg Pike
Falls Church, VA 22041-3258

Dean
School of Medicine
Uniformed Services University of the Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814-4799

Department of Military and Emergency Medicine
Uniformed University of Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814-4799

Stimson Library
Army Medical Department Center & School
ATTN: Chief Librarian
Bldg 2840, Room 106
Fort Sam Houston, TX 78234-6100

Commandant
Army Medical Department Center & School

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

ATTN: Director of Combat Development
Fort Sam Houston, TX 78234-6100

Commander
U.S. Army Medical Research Institute of Chemical Defense
ATTN: SGRD-UVZ
Aberdeen Proving Ground, MD 21010-5425

Commander
U.S. Army Medical Material Development Activity
ATTN: SGRD-UMZ
Fort Detrick
Frederick, MD 21701-5009

Commander
U.S. Army Institute of Surgical Research
ATTN: SGRD-USZ
Fort Sam Houston, TX 78234-6200

Commander
U.S. Army Medical Research Institute of Infectious Disease
ATTN: SGRD-UIZ
Fort Detrick, MD 21701-5011

Director
Walter Reed Army Institute of Research
ATTN: SGRD-UWZ-C (Director for Research Management)
Washington, DC 20307-5100

Commander
U.S. Army Natick Research, Development & Engineering Center
Natick, MA 01760-5000

Commander
U.S. Army Natick Research, Development & Engineering Center
ATTN: SATNC-IU
Natick, MA 01760-5019

Commander
U.S. Army Natick Research, Development & Engineering Center
ATTN: SATNC-ICC
Natick, MA 01760-5019

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

Commander
U.S. Army Research Institute for the Social and Behavioral Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

Commander
U.S. Army Training and Doctrine Command
Office of the Surgeon
ATTN: ATMD
Fort Monroe, VA 23651-5000

Director, Biological Sciences Division
Office of Naval Research - Code 141
800 N. Quincy Street
Arlington, VA 22217

Commanding Officer
Navy Environmental Health Center
2510 Walmer Avenue
Norfolk, VA 23513-2617

Commanding Officer
Naval Aerospace Medical Institute (Code 32)
Naval Air Station
Pensacola, FL 32508-5600

Commanding Officer
Naval Medical Research Institute
Bethesda, MD 20889

Commanding Officer
Naval Health Research Center
P.O. Box 85122
San Diego, CA 92138-9174

Commander
Armstrong Medical Research Laboratory
Wright-Patterson Air Force Base, OH 45433

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

Commander
USAF Armstrong Medical Research Laboratory
ATTN: Technical Library
Brooks Air Force Base, TX 78235-5301
Commanding General
U.S. Army Safety Center
Ft. Rucker, AL 36362

Commander
U.S. Army Infantry School
Ft. Benning, GA 31905

Commander
JFK Special Warfare Center and School
ATTN: AOJK-SU
Ft. Bragg, NC 28307

Director
Army Physical Fitness Research Institute
Army War College
Carlisle Barracks, PA 17013

Director
Military Performance Division
USARIEM
Natick, MA 01760

Director
Human Research and Engineering Directorate
U.S. Army Research Laboratory
Aberdeen Proving Ground, MD 21040

Chief
Individual Performance Branch
Human Research and Engineering Directorate
U.S. Army Research Laboratory
Aberdeen Proving Ground, MD 21040

Chief, Preventive Health Services Division
ATTN: MCHO-CL-W
USAMEDCOM
Ft Sam Houston, TX 78234

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

Preventive Medicine Consultant
HQDA, Office of the Surgeon General (DASG-HSZ)
5109 Leesburg Pike
Falls Church, VA 22041-3258

DCCS/OM Consultant
USAMEDDAC
1585 3rd Street
Ft Polk, LA 71459

Director, Division of Preventive Medicine
ATTN: MCMR-UWK
Walter Reed Army Institute of Research
Washington, DC 20307-5100

Program Director, Public Health Residency
Preventive Medicine Service
ATTN: MCHJ-PV
MAMC
Tacoma, WA 98431

Preventive Medicine Consultant
18th MEDCOM
Unit 15281, Box 763
APO AP 96205

Chief, Preventive Medicine Service
Build 1001
2421 Dickman
Ft Sam Houston, TX 78234

Director, Preventive Medicine, Great Plains RMC
Build 1001
2421 Dickman
Ft Sam Houston, TX 78234

Chief, Preventive Medicine Service
USAMEDDAC
Ft Jackson, SC 29207-5720

Chief, Department of Preventive Medicine

Epidemiological Consultation No.29-HE-7513-98, Ft Jackson, SC, 1997

USAMEDDSC-AK
1060 Gaffney Rd #7440
Ft Wainwright AK 99703

Chief, Department of Epidemiology
ATTN: MCMR-UWK-B
Division of Preventive Medicine
WRAIR
Washington, DC 20307-5100

Director of Medical Epidemiology
Deployment Surveillance Team
5113 Leesburg Pike
Falls Church, VA 22041

Chief, Preventive Medicine Service
USAMEDDAC
650 Joel Rd
Ft Campbell, KY 42223-5349